Title: Polygons and Polyhedrons

Link to Outcomes:

● **Problem Solving**   Students will investigate polygonal and polyhedron shapes and relationships by hands on manipulation, three-dimensional modeling (i.e., construction of a tetrahedron kite), and computer generated graphics. Predictions of flight possibilities will be based on the different shapes and combinations of shapes.

● **Communication**   Students will communicate with in-group settings, by oral presentation of their findings, and by writing.

● **Reasoning**   Students will reason about the possible relationships between polygons and polyhedra, and numerical patterns involved in the construction of each.

● **Connections**   Students will develop and connect mathematical formulae and design to everyday real-world objects. Students will gain an appreciation for the mechanics of kite flight.

● **Geometry**   Students will experience applications of angle construction, area, surface area, and volume. In addition, students will appropriately use the vocabulary, definitions, and rules as they apply to similar figures.

● **Measurement**   Students will need to make precise linear measurements, as well estimation of length. Students must also calculate various areas, surface areas, and volumes.

● **Arithmetic Operations**   Students will use basic math operations to solve problems.

● **Patterns/ Relationships**   Students will discover patterns and relationships between vertices, edges, and interior/exterior angle measures of polygons, as well as between vertices, edges and faces of polyhedrons. Students also will develop an understanding of area, volume and surface area.

Brief Overview:

In this unit, students define and recognize relationships between the sides and angles of regular polygons, and develop a formula. Students make predictions and extensions based on their discoveries, and define and develop relationships between vertices, edges, and faces of polyhedra. Development occurs via the use of manipulatives, group discussion, class discussion, and directed discovery. The lesson ends by making and flying a tetrahedral kite.

Grade/Level:

Appropriate for grades 6 - 10.

Duration/Length:

This lesson can be accomplished in 2-3 class periods, but can easily be extended to take 3-4 periods with discussion, prediction and analyses.

Prerequisite Knowledge:

Prerequisite knowledge of measurement, basic geometric concepts (i.e., area, surface area, and volume), definitions of polygon and polyhedra, and pattern recognition are required.

Objectives:

Students will be able to:

- recognize basic polygonal and polyhedral shapes and use accepted nomenclature in discussions.
- construct both polygonal and polyhedral shapes.
- determine relationships between various attributes (i.e., edges, faces, etc.).
- calculate area, volume, and surface area of some shapes.
- discover patterns and formulas to predict non-standard figures.
- discuss mathematically their findings.
- build and fly a polyhedral kite.

Materials/Resources/Printed Materials:

- construction paper, writing paper, graph paper, scissors, glue, tape, rulers, pen/pencil, and compass
- per student: one sheet of tissue paper, 24 drinking straws, 288 inches of string, spool of kite string, and kite assembly instructions (included)
- overhead pattern blocks
- Regular Polygon Worksheet (included)

Development/Procedures:

Day 1

- Introduce polygons vs. non-polygons as a warm-up exercise by means of overhead pattern blocks, simple closed curves, and other non-descript shapes. In groups, develop a working definition of polygons. As a class, agree upon the distinguishing characteristics.

- Lead classroom discussion on polygon naming conventions.

- Provide groups with the Regular Polygon Worksheet. Remind students that every triangle's interior angles total 180 degrees. Have groups divide polygons into triangles by connecting a single vertex to each of the other vertices using a straight-edge. Have students fill out Polygon Discovery Chart (P.D.C.). Ask groups to complete the information in the chart for polygons not drawn on the worksheet. As a class, discuss group findings. Have students suggest patterns for making predictions.

Day 2

- Using a compass, straight-edge, construction paper, and information from the P.D.C. students individually construct simple regular polygons, all with equal side lengths. Cut out polygons and trace onto graphing paper. Discuss perimeter and area estimates based on one graph block equaling one unit. Have students investigate possible patterns to aid predictions for area of other polygons. Students can also examine the different polyhedra through simple combinations of the polygons. Suggest the tetrahedron from triangles and the dodecahedron. Have students develop a worksheet similar to the one on polygons. Allow students to suggest the content they feel would best help them to explore polyhedral relationships.

Day 3

- Distribute tetrahedral kite instructions and materials. Have students work in pairs to build individual kites.

- Go fly a kite!

Evaluation:

Teacher circulates to keep students on task. Class discussion helps students evaluate individual and group conclusions. Student predictions demonstrate understanding of concepts and patterns.

Extension/Follow Up:

Create other polyhedrons from various polygons. Do the relationships discussed still hold?

Compare and contrast these relationships with those of the polygons.

Calculate and estimation of surface area and volume of polyhedra.

Have teams build kites of experimental design; then have flying competitions.
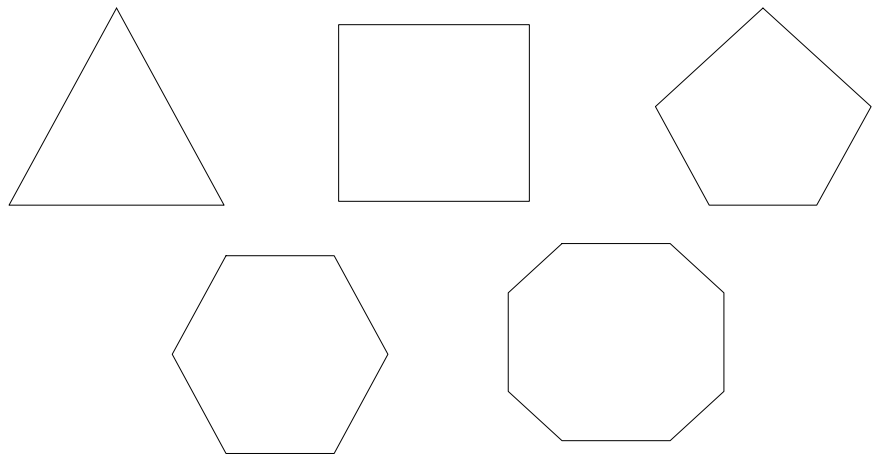
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Regular Polygon Worksheet

1. Divide each of the regular polygons above into triangles by drawing a line from one of its vertices to each of its other vertices.

2. Use these drawings and the fact that every triangle's interior angle measures total 180 degrees to complete the Polygon Discovery Chart below.

3. Try to come up with a pattern or formula to help you finish the chart without having to draw the remaining polygons. Will this method work for polygons that are not regular? Explain.

Polygon Discovery Chart

# of Sides	Name of Regular Polygon	# of Triangles	Sum of Interior Angles (# Triangles X 180)	Measure of each Interior Angle (Sum of angles/# of angles)
3	Triangle	1	180 degrees	60 degrees
4	Square			
5				
6				
7				
8				
9				
10				
12				
20				